IMAGE DISPLAY DEVICE

BY

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BACKGROUND OF THE INVENTION

The present invention relates to an image display device. More particularly, this invention relates to an image display device that provides a simulated three-dimensional image with a concave mirror.

Three-dimensional imagery has long been enjoyed by millions of people worldwide. Theme parks, movie houses, video arcades, and I Max type theaters have offered this exciting technology for years. The production of these offerings is expensive, the space requirements can be enormous, and, in most cases, the viewer has to use special glasses for viewing. While these glasses may be suitable for the many uses, or for general use, such as when one is seated in a theater, they would not be as suitable for many of the purposes planned by the inventor.

Two dimensional imagery has been employed for many years by many advertisers, producers, and educators in stationary kiosks, wall or ceiling mounted monitors, and overhead screens in a variety of locations such as trade shows, retail outlets, shopping centers, museums, and

schools. The kiosks are small and do not require much floor space and the wall or ceiling mounted monitors and the large screens provide an effective means to display large images. Two-dimensional imagery does not require the viewer to use the special glasses but is still the attention getter desired by the owner/advertiser.

US Patent No. 4,776,118 discloses a display device that includes a concave mirror that reflects light from a light source inside the device and forms a real image that is viewable outside the device. The display device of '118 is an example of an image display device that can provide a simulated three-dimensional image.

SUMMARY OF THE INVENTION

The present invention provides an improved construction for an image display device that employs a concave mirror to provide simulated three-dimensional image.

An objective of the invention is to provide an image display device that can display high quality, simulated, three-dimensional images, and that can be produced at reasonable manufacturing cost.

Another objective of the invention is to provide a mirror supporting device that can support a concave mirror,

which is the central optical element of the image display device, stably and accurately.

Still another objective of the invention is to provide an image display device that provides images changeable with user interaction.

To achieve the above objectives, an aspect of the invention provides an image display device having a case with an opening, a luminous source image display displaying a first image, and a focusing element receiving light from the source image display and focusing the light to form a second image that is viewable through the opening of the case. The source image display and the focusing element are positioned within the case. The focusing element includes a concave mirror and a mirror supporter that supports the concave mirror, and the perimeter of the concave mirror includes at least one straight-cut portion that has a line contact with the mirror supporter.

The concave mirror is substantially having a shape of a partial spherical surface. The concave mirror is made by vacuum drawing a flat plastic plate into a hemispherical shape, and cutting the drawn plate into a predetermined shape. Preferably, the concave mirror is underdrawn. More preferably, the concave mirror is underdrawn by 12%.

The concave mirror has a front surface and a back surface. The front surface directs toward the opening, and the back surface is coated with substantially black material.

Preferably, the perimeter of the concave mirror includes two of the straight-cut portions and they are parallel with each other.

Preferably, a flexible strip is provided between the straight-cut portion and the mirror supporter.

The mirror supporter includes two side panels and a back panel that connects the two side panels. The side panel forms a line contact with the straight-cut portion. The back panel covers and protects the back surface of the concave mirror.

The mirror supporter can be pivoted whereby the concave mirror can be pivoted. Each of the side panels includes a pivot axis around which the mirror supporter can pivot.

One of the side panels further includes a lock member that blocks pivoting of the mirror supporter.

The back panel includes at least one supporting portion that supports the concave mirror between the side panels.

In another embodiment of the mirror supporter, each of the side panels includes a wing that extends opposite the concave mirror and beyond the back panel. The wing includes one or more attaching points that attach the mirror supporter to the case. This facilitates assembly of the mirror supporter from backside of the case.

The image display device further includes an image source that provides image information to the source image display, so that the source image display displays the first image. The image source may be a DVD player or a computer.

The image display device further includes a sensor device that senses position of a user's hand in a plane at the opening. The sensed position is used to change the image information provided by the image source, so that the second image is changed by interaction with a user.

Another aspect of the invention provides an image display device including a case with an opening, a luminous source image display displaying a first image, and a focusing element receiving light from the source image display and focusing the light to form a second image that is viewable through the opening of the case. The source image display and the focusing element are positioned within the case. The focusing element includes a concave

mirror and a mirror supporter that supports the concave mirror, and the perimeter of the concave mirror includes two parallel straight-cut portions, each of which has a line contact with the mirror supporter.

Still another aspect of the invention provides an image display device including a case with an opening, a luminous source image display displaying a first image, a focusing element receiving light from the source image display and focusing the light to form a second image that is viewable through the opening of the case, and an image source providing image information to the source image display so that the source image display displays the first image. The source image display and the focusing element are positioned within the case. The focusing element includes a concave mirror and a mirror supporter that supports the concave mirror. The perimeter of the concave mirror includes at least one straight-cut portion that has a line contact with the mirror supporter. The image information provided by the image source is changed with user interaction.

The advantages of the present invention are: (1) a portable, reasonably priced, simulated three-dimensional display is provided; (2) the concave mirror in the display

is easy to assemble and positioned stably; (3) display effect is enhanced by the interactive feature.

Although the present invention is briefly summarized, the fuller understanding of the invention can be obtained by the following drawings, detailed description and appended claims.

DESCRIPTION OF THE FIGURES

These and other features, aspects and advantages of the present invention will become better understood with reference to the accompanying drawings, wherein:

FIG. 1 is a front elevation view of the image display device of the present invention;

FIG. 2 is a cross-sectional view of the image display device taken along the line 2-2 in FIG. 1;

FIG. 3 is a perspective view of a focusing element;

FIG. 4 is a front elevation view of the focusing element;

FIG. 5 is a cross-sectional view of the focusing element taken along the line 5-5 in FIG. 4;

FIG. 6 is a detailed cross-section view of the focusing element taken along the line 6-6 in FIG. 4;

FIG. 7 is a perspective view of a concave mirror;

FIG. 8 is a front elevation view of the concave mirror;

FIG. 9 is a cross-section view of the concave mirror taken along the line 9 - 9 in FIG. 8;

FIG. 10 is a perspective view showing another embodiment of a mirror supporter; and

FIG. 11 is a schematic cross-section view showing a sensor device.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 shows an image display device **10** according to the present invention. The image display device **10** includes a case **12** with an opening **14**, a luminous source image display **16** displaying a first image **17**, and a focusing element **18** receiving light from the source image display **16** and focusing the light to form a second image **19** that is viewable through the opening **14** of the case **12**. The focusing element **18** and the source image display **16** is positioned within the case **12**. The source image display **16** may be a CRT monitor, a flat panel display or any other luminous image display. The wiring to connect the various electric components has been omitted for clarity. In front of the case **12**, there is a sloping face **60** below the opening **14**. The sloping face **60** is sloped at about 60° from

the horizontal and, provides the transition to the lower part of the case **12**, which is wider than the upper part of the case **12**. The sloping face **60** prevents viewers from placing drinks, cigarettes, etc. on the case **12**. Inside the case **12**, a shelf **62** is provided below the source image display **16**. The shelf **62** supports the source image display **16**, and partitions the case **12**, so that an image source **52**, which is explained later, may be positioned below the shelf **62**.

FIGS. 3 - 6 show the focusing element **18**. The focusing element **18** includes a concave mirror **20** and a mirror supporter **22** that supports the concave mirror **20**. The perimeter of the concave mirror **20** includes at least one straight-cut portion **24** that has a line contact with the mirror supporter **22**. The mirror supporter **22** is designed to stabilize the concave mirror **20** during assembly, shipping, and normal moving during use.

The case **12** blocks any light from outside so that only the light from the source image display **16** can reach the concave mirror **20**.

FIGS. 7 - 9 show the concave mirror **20**. The concave mirror **20** is substantially having a shape of a partial spherical surface. The concave mirror **20** is made by vacuum

drawing a flat plastic plate into a hemispherical shape, and cutting the drawn plate into a predetermined shape.

The concave mirror **20** is made by the following process. A flat acrylic plastic plate ($1/8^{th}$ thickness) is vacuum drawn to a hemi-spherical dome. The hemispherical dome is coated with a high-density acrylic black coating. Then the dome is bisected into quarters. To obtain quality required for a mirror, care should be taken in selection of pure material and precision equipment for the process. The magnitude of vacuum, temperature, and rate of draw in the vacuum drawing process must be controlled within strict tolerance ranges.

The shape of the concave mirror **20** is three-dimensional. Straight-cut portion **24** means that the portion looks straight when viewed from a specific direction. FIG. 8 shows the concave mirror **20** in an elevation view, and two parallel straight-cut portions **24**.

When the concave mirror **20** is drawn to the shape of a hemispherical dome, the radius from anywhere of the dome is the same. The effects of overdrawing and underdrawing were researched. It was determined that a mirror that was drawn to a depth of twelve percent short of its radius provided the most ideal image. That is, prefeably, the concave mirror **20** is underdrawn. More preferably, the concave

mirror **20** is underdrawn by 12%. The 12 % underdrawing may be expressed: D = 0.88 R. D is the distance between the farthest point of the vacuum drawn mirror, and the plane of the flat acrylic plate before vacuum drawing. R is the radius of the ideal hemisphere.

The concave mirror **20** has a front surface **26** and a back surface **28**. The front surface **26** directs toward the opening **14** when the concave mirror **20** and the mirror supporter **22** are assembled in place in the case **12**. The back surface **28** is coated with substantially black material.

The perimeter of the concave mirror **20** includes two straight-cut portions **24**, and the straight-cut portions **24** are parallel with each other, as shown well in FIG 8.

The mirror supporter **22** includes two flat side panels **32** and a back panel **34** that connects the two side panels **32** and protects the concave mirror **20**. The two side panels **32** of the mirror supporter **22** form line contacts with the two straight-cut portions **24** of the concave mirror **20**. These line contacts distribute the load between the concave mirror **20** and the mirror supporter **22**, and prevents local stress concentration. Therefore, the concave mirror **20** is free from distortion that might be induced from locally concentrated stress, and the resulting optical image is

free from optical distortion that might be caused by physical distortion of the concave mirror 20.

Referring back to FIG. 6, a flexible strip **30** is provided between the straight-cut portion **24** of the concave mirror **20** and the side panel **32** of the mirror supporter **22**. The strip **30** facilitates more uniform support of the concave mirror **20** by the mirror supporter **22**.

The mirror supporter **22** can be pivoted so that the concave mirror **20** can be pivoted. This enables adjustment of position of the concave mirror **20** within the case **12**. Each of the side panels **32** includes a pivot axis **36** around which the mirror supporter **22** can pivot. Two pivot screw **38** provided on the side panels **32** form the pivot axis **36**.

One of the side panels **32** further includes a lock member **40** that blocks pivoting of the mirror supporter **22**. After positional adjustment of the concave mirror **20** is done, the lock member **40**, which may be a screw, is engaged.

The back panel **34** includes at least one supporting portion **42** that supports the concave mirror **20** between the side panels **32**. While the line contacts between the side panels **32** and the concave mirror **20** mainly support the concave mirror **20**, the supporting portion **42** provides mainly guiding and fixing the position of the concave mirror **20**.

FIG. 10 shows another embodiment of a mirror supporter **43**. The mirror supporter **43** has two side panels **44** and a back panel **46**. The side panels **44** and the back panel **46** of the mirror supporter **43** are similar to the side panels **32** and the back panel **34** of the mirror supporter **22**, but each of the side panels **44** includes a wing **48** that extends opposite the concave mirror **20** supported by the mirror supporter. The wing **48** includes two attaching points **50** that attach the mirror supporter **43** to the case **12**. This embodiment facilitates assembly of the mirror supporter **43** within the case **12**.

Preferably, the mirror supporter **22** shown in FIGS. 3 and 4 is used when the case **12** is designed for horizontal installation, and the mirror supporter **43** shown in FIG. 10 is used when the case **12** is designed for vertical installation. However, the shapes and features of the mirror supporters **22**, **43** can be applied in any directional installation of the image display device **10**.

Referring back to FIG. 2, the image display device **10** further includes the image source **52** that provides image information to the source image display **16**, so that the source image display **16** displays the first image. Preferably, the image source **52** is a DVD player or a

computer. A computer may provide more advanced interactive function than a DVD player.

FIG. 11 shows that the image display device **10** further includes a sensor device **54** that senses position of a user's hand in a plane at the opening **14**. The sensor device **54** includes an array of sensors arranged around the opening **14**. The area of the opening **14** is divided into sections with the array of sensors. The sensed position or section by the sensor device **54** is used to change the image information provided by the image source **53**, so that the second image is changed by interaction with a user. A plexiglass screen **56** may be provided to keep viewers from touching the concave mirror **20**. Speaker unit **58** is also provided around the opening **14**.

The invention uses a hemispherical mirror in combination with other commercially available technical products to produce a cost effective three dimensional theater. The concave mirror can be used to project life size or larger images for venues that would require larger than those in the kiosk. Accordingly, the mirror is manufactured in a much larger size to accommodate the owner or advertiser's needs. The invention seeks out additional markets for this technology. Accordingly, the mirrors may

be made larger or smaller, and the radii and the depth relationships may change.

The invention is related to produce a three dimensional image with an optional interactive feature in a theater/kiosk product. Potential customers can not only listen and view the three-dimensional promotional presentation and then, depending on the nature of the advertiser's market or desired buyer impact, viewers can also call up or select other products or services by reaching into the theater and "touching" the presenter or a menu shown on the screen.

To best serve customer needs and minimize floor space, the theater or the image display device **10** will be self standing (the vertical design) like many kiosks presently in service today, or it can be hung from a ceiling point. The image display device can also be placed on a counter (the horizontal design) for use in department stores, fast food outlets, etc.

The image display device is light enough to permit easy handling and moving. The image display device will be supplied with casters for easy moving. The case would normally be constructed of strong, durable, prefinished wood in a variety of colors. Plastic, brushed metal, or covered fabric may also be used. The lower portion of the

front of the case, as well as the sides, will be available for additional advertising by the owner.

The image display device or kiosk is not unduly expensive. The durable nature of the components and the ability to change the video content of the programming at reasonable cost will enable the advertiser/producer to use the theater for may years with the cost effective opportunity to spread the costs of the video programming and production over multiple locations.

When the advertiser inserts his personalized DVD into the DVD player or turns on the computer, the presentation begins. When using the interactive unit, at selective times during the presentation, the viewer will be asked to touch the image's nose, ear, eye or some other image on the screen on the screen (such as a color chart or a list of products). When the viewer's finger or hand intersects with the sensor system in the location called for, the next image appears in the theater and continues the presentation. The sequences continue until the end of the presentation. The walls of the opening **14** project backward from the front of the case **12** to produce a darkened opening area reminiscent of a theater.

While the invention has been shown and described with reference to different embodiments thereof, it will be

appreciated by those skilled in the art that variations in form, detail, compositions and operation may be made without departing from the spirit and scope of the invention as defined by the accompanying claims.